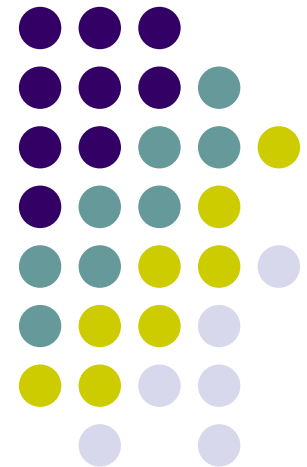


# Automated Analytical Laboratory

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# Background



- High flux UV exposure studies on the NIST SPHERE result in short exposure times and rapid sample turnover.
- Research needs:
  - Automated and rapid analysis of specimens under study
  - Storage and processing of massive amounts of analytical data
  - Parallel measurement systems
- No satisfactory commercial solution exists for either of these needs.



# Background

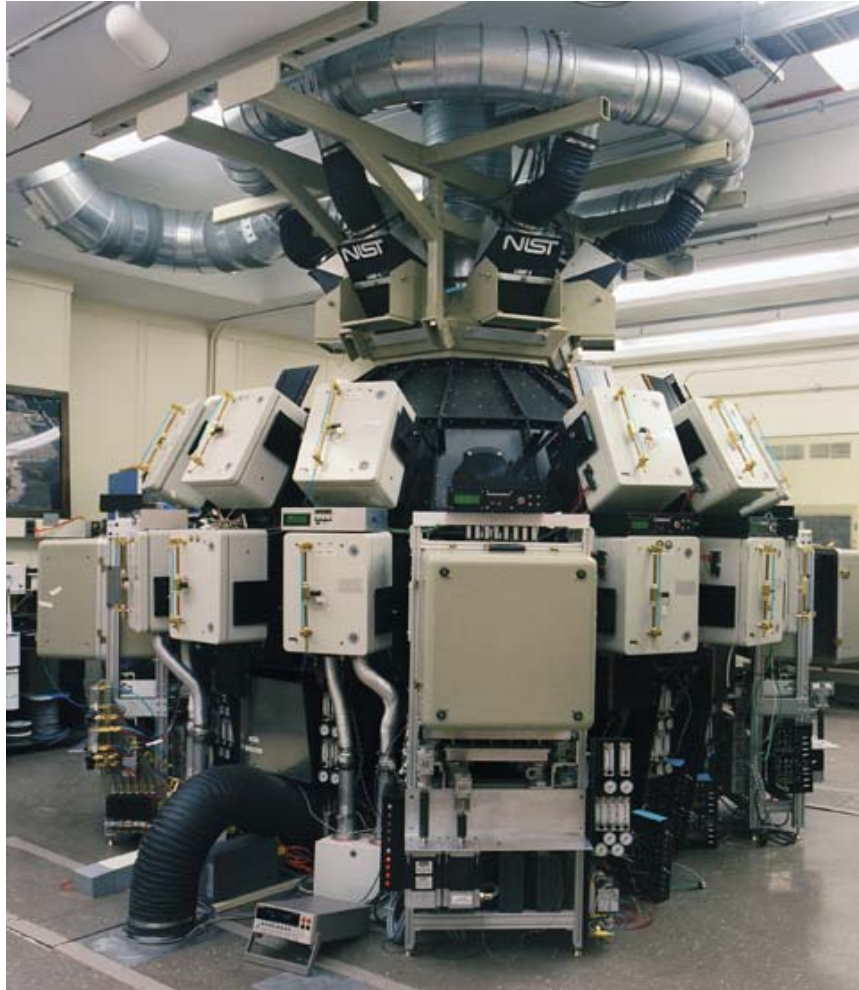


A comprehensive high throughput research program includes:

- Combinatorial methods for making specimens
- Accelerated aging process [NIST SPHERE]
- High throughput specimen characterization
- Informatics



# High Throughput UV Exposure



For one experiment:

32 ports

17 specimens/port

Typically, 6 different types of measurements/experiment

Typically, 50 measurement intervals/experiment

> **160,000 measurements per experiment!**

(x4 for replicates)

# High Throughput UV Exposure Current Methodology



## REMOVE SPECIMENS



## FTIR (Samples)



4 Specimens  
~ 6 hours

## UV-VISIBLE (Samples & Filters)



## REPLACE SPECIMENS



FTIR: 45 min  
UV-Vis: 20 min



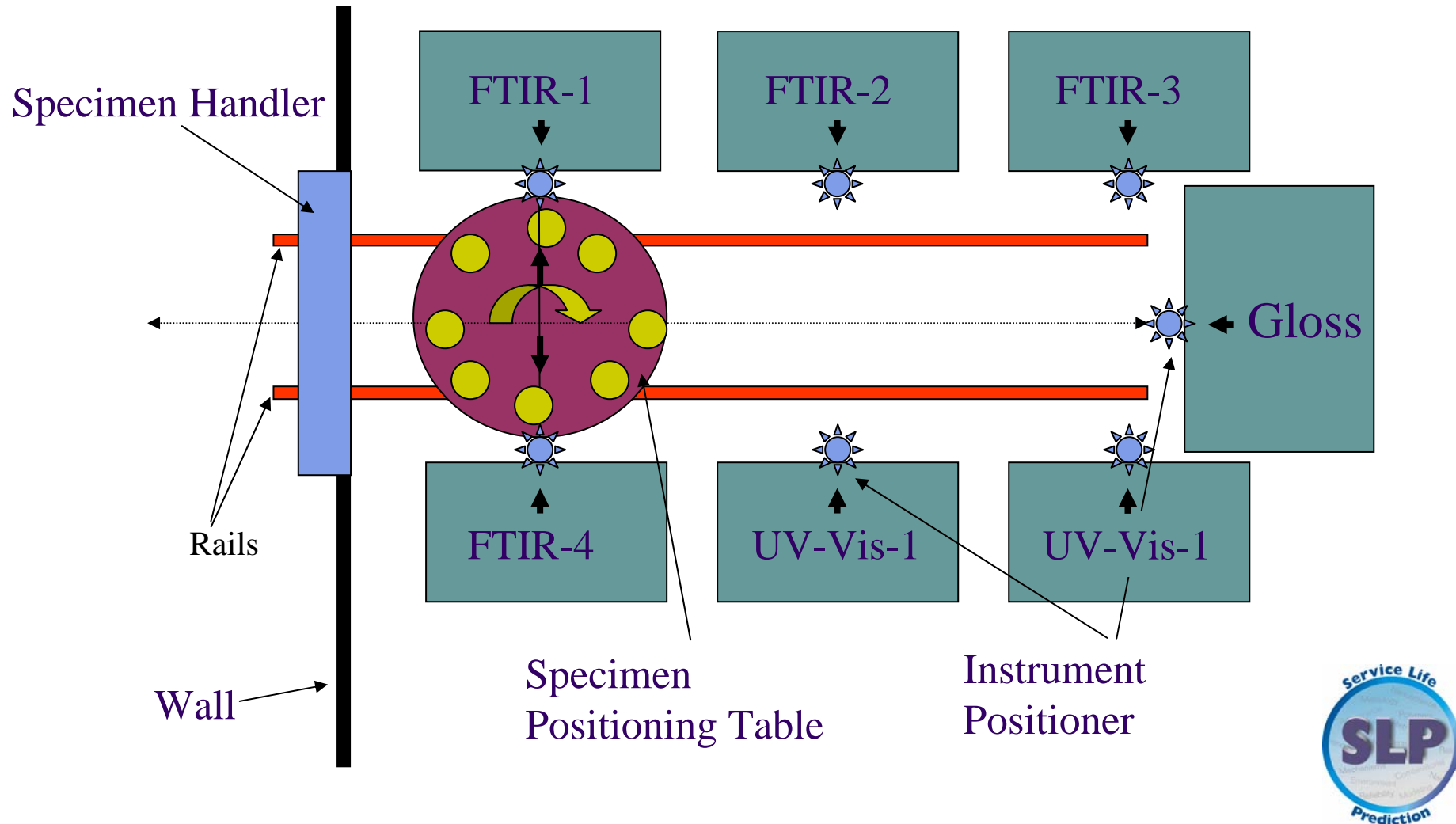
# Goals



- Decrease specimen measurement time by a factor of at least 20 without sacrificing data integrity
- Minimize specimen handling to decrease errors.
- Standardize calibration and measurement protocols over multiple instrument platforms.
- Ensure enough flexibility and capacity for future needs.



# Automated Analytical Design Proposal



# Specimen Handling & Analytical Instruments



- Specimen Handling
  - 7-Axis Robot
  - Specimen Handler
  - Instrument Positioners
- Analytical Instruments
  - FTIR
  - UV-Vis
  - Glossmeter





# 7-Axis Robot



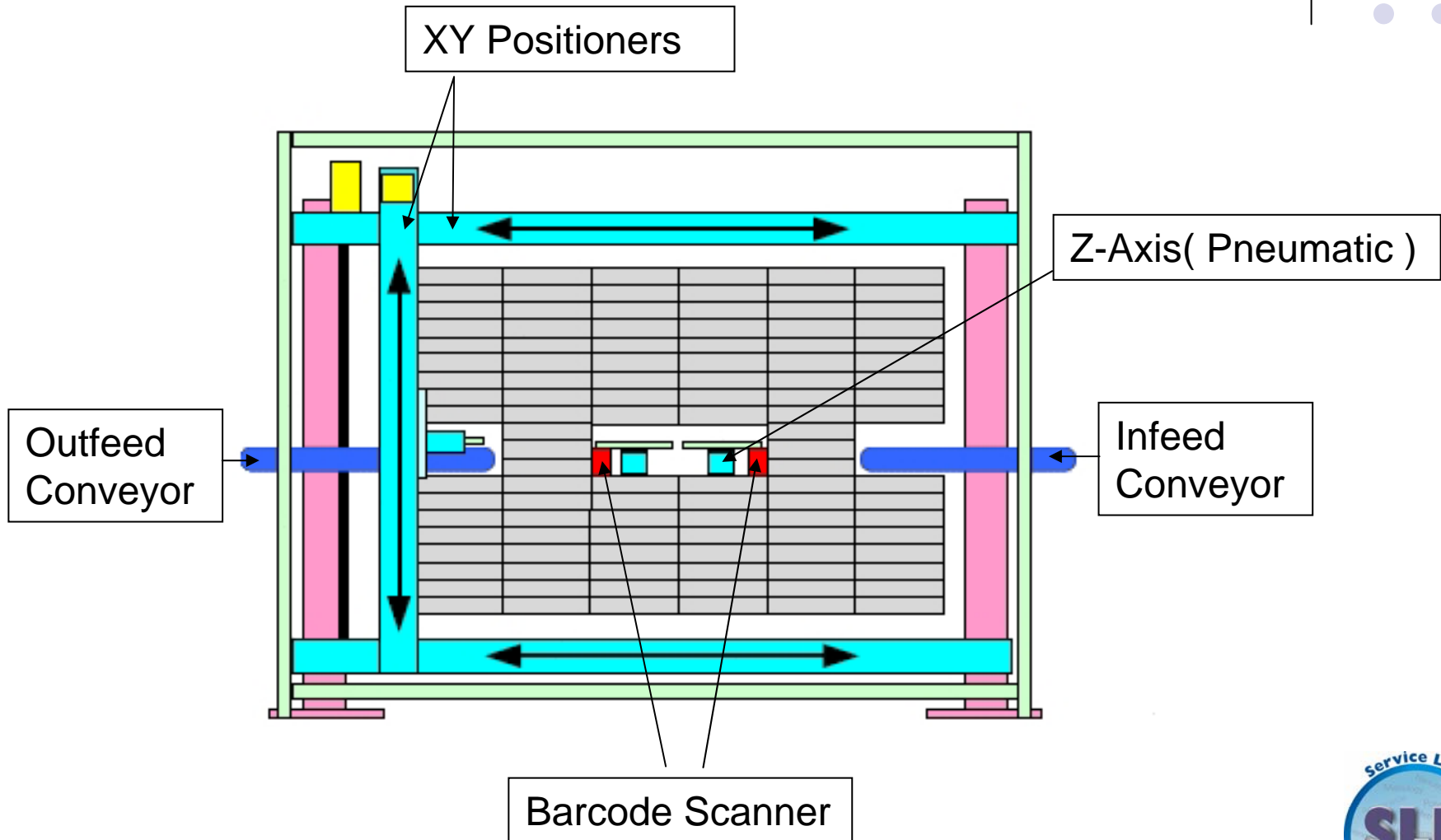
# 7-Axis Robot Specifications



- Designed for laboratory use
- Seven degrees of freedom
  - 4 meter track
- Absolute encoders, no homing
- Payload: 3kg
- Reach (std. gripper): 863 mm
- Repeatability: +/- 0.05mm
- Weight 53 kg

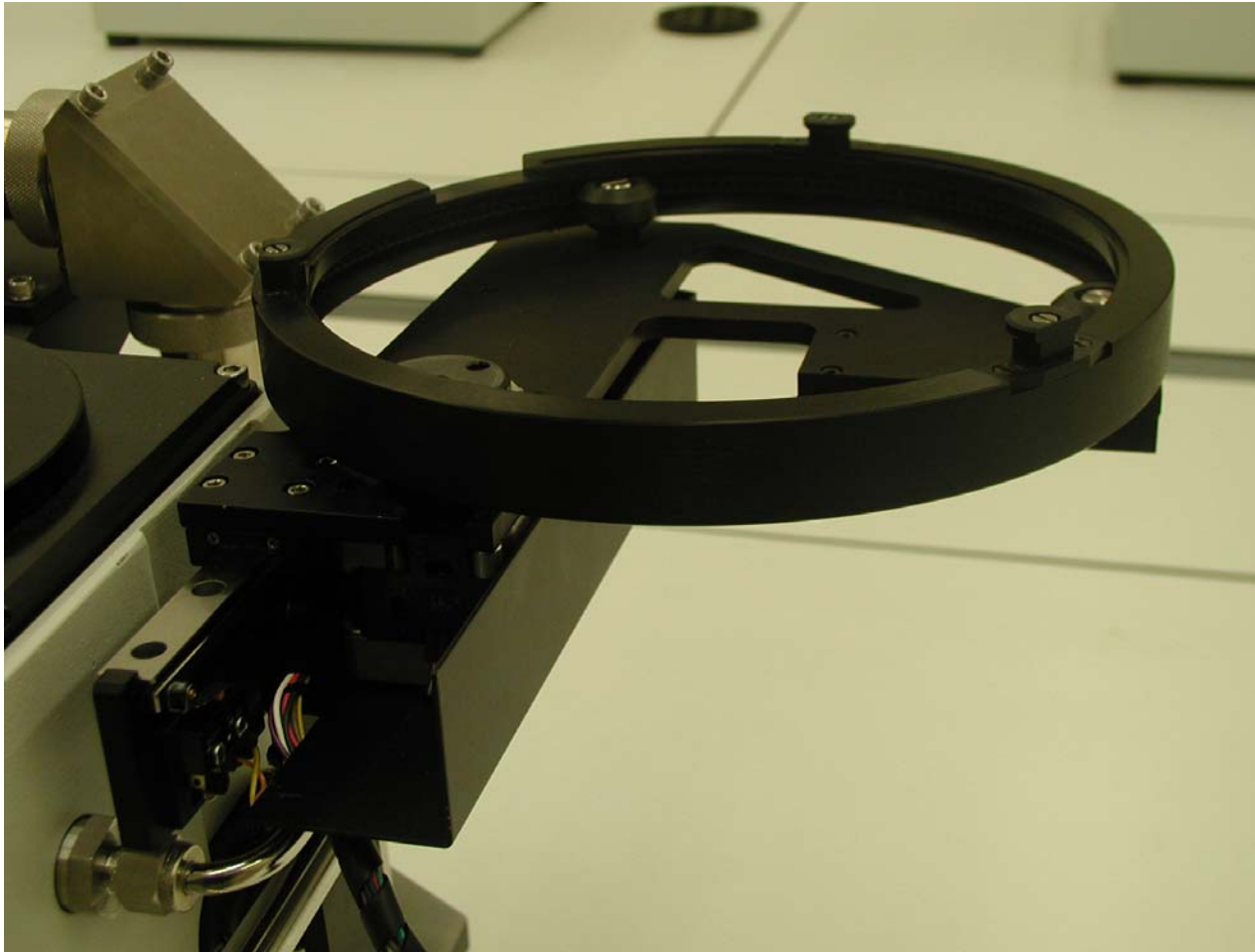


# Proposed Specimen Handler



# Instrument positioners

## radius-theta positioner



# Instruments



- FTIR
- UV-Vis
- Glossmeter
- Instrument assemblies (instruments + positioners) will be interchangeable.
  - Easily removable for maintenance
  - Modular programming
  - All components have a small “footprint”



# MIDAC Illuminator FTIR



## Interferometer

Type: 90° Michelson with duplexed mechanical bearings and linear force motor

Mirror Control: HeNe laser with quadrature phase detectors

Mirrors: Gold coated, diamond turned, permanently aligned

IR Source: 1650° K, air-cooled, permanently aligned

Resolution: 0.5 or 1 cm<sup>-1</sup>, (step adjustable to 32 cm<sup>-1</sup>)

Optics: KBr, ZnSe, or CaF<sub>2</sub> beamsplitter and windows

Abscissa: 7800-350 cm<sup>-1</sup> for KBr

Accuracy: >0.01 cm<sup>-1</sup>

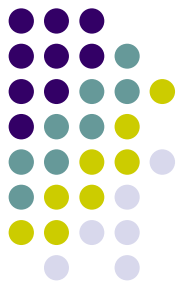
Detector: DTGS or LN<sub>2</sub> cooled MCT or InSb  
(separate external module)

Dimensions: 8" x 14" X 8" (W x D x H)

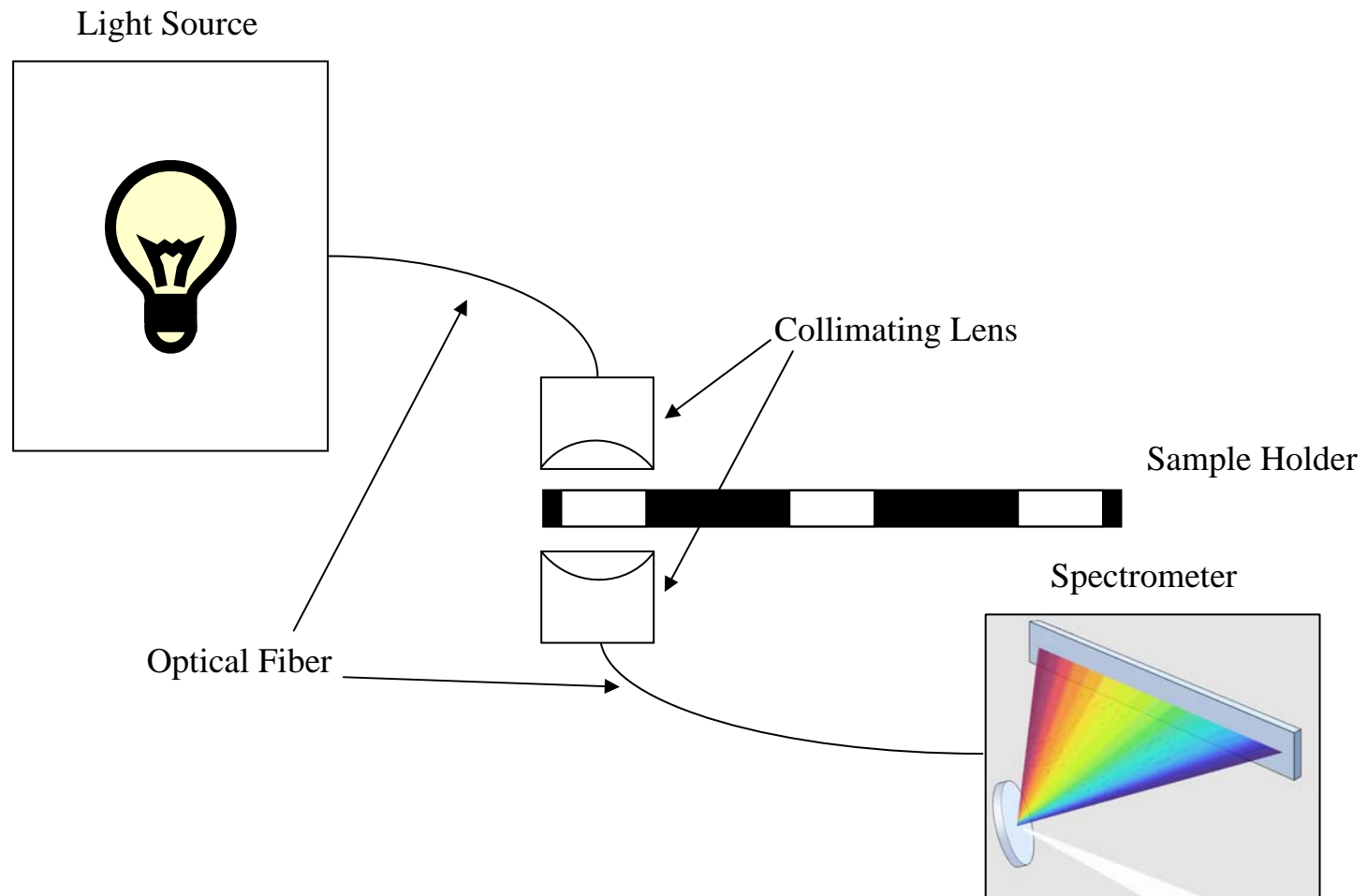
[www.midac.com](http://www.midac.com)



# MIDAC Illuminator FTIR with Custom Optical Interface

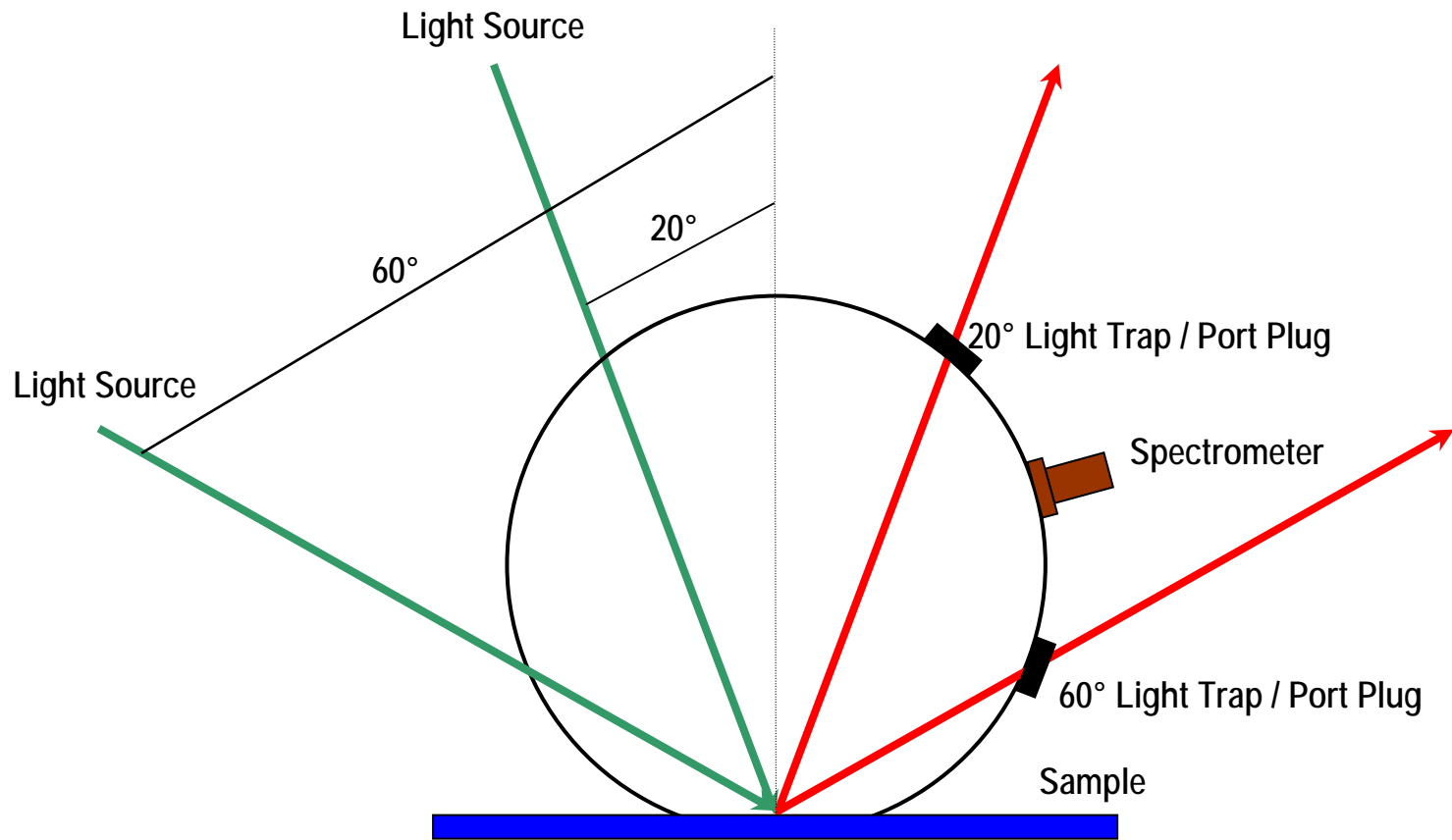


# Schematic of UV-Vis

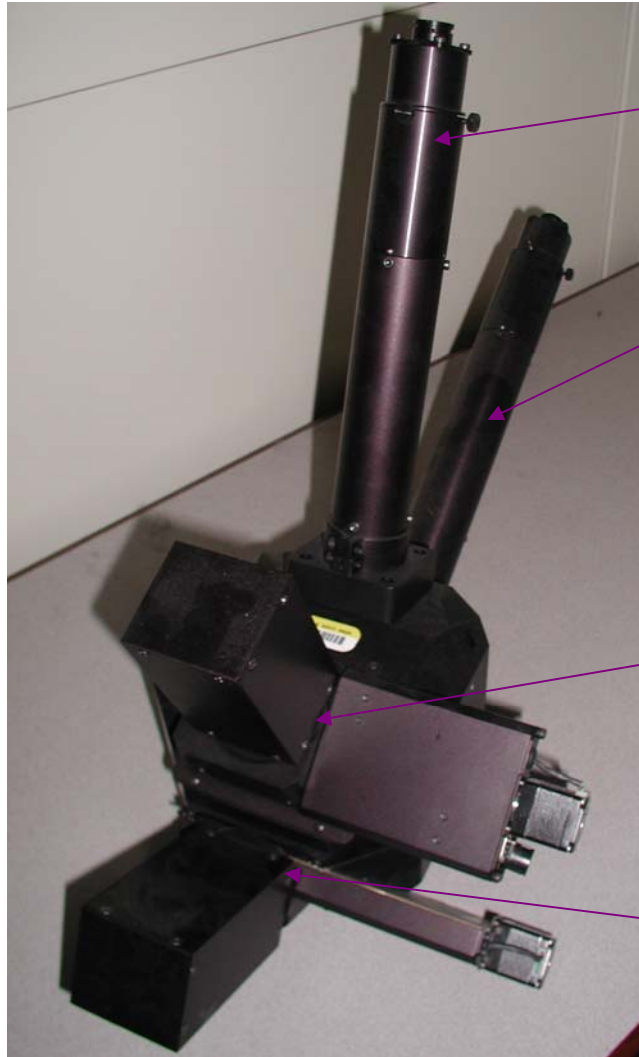




# 20°/60° Glossmeter



# 20°/60° Glossmeter



60° Light Source

20° Light Source

60° Port Plug/Light Trap

20° Port Plug/Light Trap

# Calibration



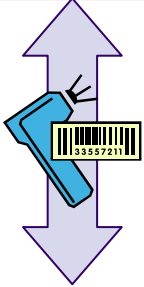
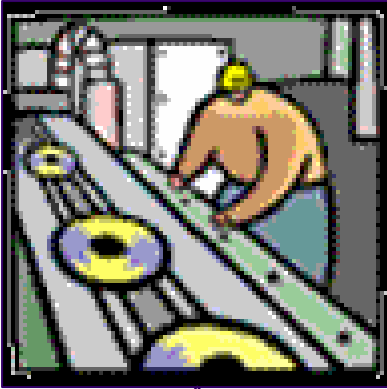
- NIST Standard Reference Material (SRM)
  - UV-Vis
  - Glossmeter
  - FTIR
- Calibrations will be performed routinely



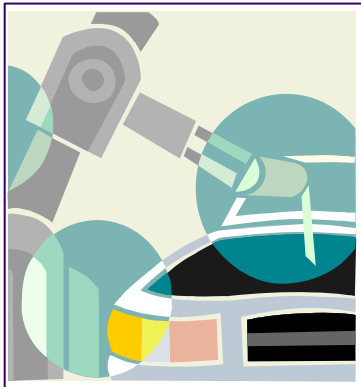
# Sampling methodology



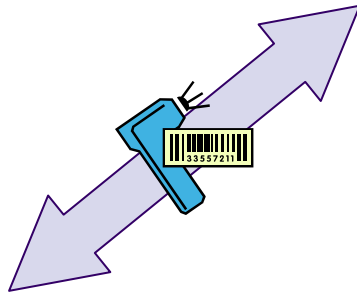
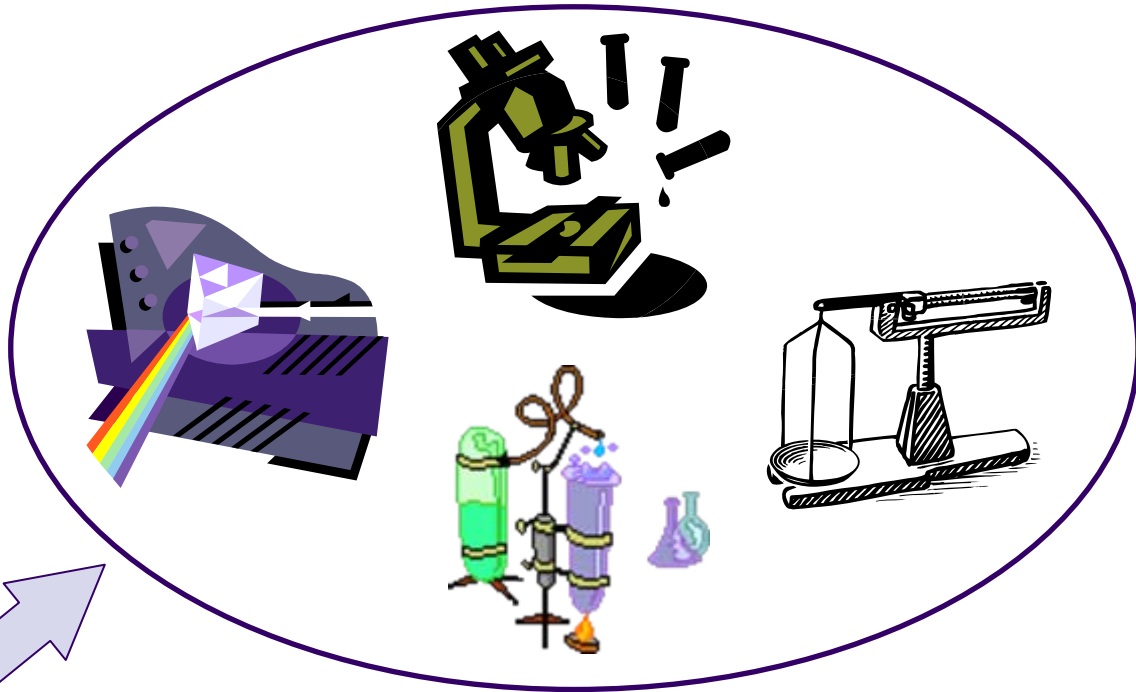
Specimen Handler



Robot



Instruments



# Additional Instruments



- FTIR – ATR
- UV-Vis / NIR Reflection Spectrometer
- Raman Spectrometer
- Fluorescence Spectrometer
- Microscope



# Gantt chart



Y1

Y2

Y3

Y4

7-Axis Robot, FTIR-T, Glossmeter (completed)

UV-Vis Spectrometers  
Rack-Mount Computers  
Sample Handler  
Instrument Positioners

Investigate/Purchase instruments  
for pigmented samples

Implement new instruments



# Automated Analytical Laboratory

